

# PATENT SPECIFICATION

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- (21) Application No. 36260/73 (22) Filed 30 July 1973  
 (31) Convention Applications No's. 75880/72 (32) Filed 31 July 1972  
 75880/72 12 Sept. 1972 in  
 (33) Japan (JA)  
 (44) Complete Specification published 19 May 1976  
 (51) INT. CL.<sup>2</sup> B29H 17/22  
 (52) Index at acceptance  
 B7C 74E1 74E5 74E6  
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## (54) IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF PNEUMATIC TYRES

- (71) We, THE YOKOHAMA RUBBER Co., LTD., a Japanese body corporate, of No. 36-11, Shinbashi 5-chome, Minato-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 This invention relates generally to the manufacture of tyres.
- Hitherto, various bead forming devices have been proposed. One of these devices comprises a bladder adapted to turn up an edge of a carcass ply around a bead core, a bell-crank shaped backing plate following behind the bladder in operation to contact the carcass ply edge, the surfaces of the bell-crank shaped plates being adapted to support and press said bladder against the periphery of the bead core, thereby effecting the turning up and stitching of the edge of the carcass ply around the bead core.
- 25 Another type of bead forming device which has been proposed comprises a pair of separate bladders, one of which is adapted to press directly against the edge of a carcass ply, while the other is adapted to press against the outer surface of the first mentioned bladder to thereby aid indirectly in the pressing of the one bladder against the ply.
- We have found that previously proposed bead forming devices have not been entirely satisfactory. In particular, the latter type mentioned above has the short-coming that the outermost edge of the end portion of the carcass ply tends to be pressed around the bead core earlier than the remainder of the said end portion. There is the possibility of air inclusion or wrinkle formation which in turn results in the separation of layers in the bead portion when the tyre is subjected to heat during its lifetime for one

reason or another. In view of the short-comings of the previously proposed bead forming devices, we have attempted to find an improved arrangement. The present invention has arisen out of our work to this end.

In accordance with a first aspect of this invention, we provide apparatus for turning up an edge of a cylindrical carcass ply around a co-axial annular bead core member during manufacture of a tyre, the apparatus comprising: a drum for supporting said ply co-axially thereon; means for pressing said core member co-axially against one end of said drum; a multi-bladder arrangement including two inflatable bladders, one of which is located inside the other, the bladders being mounted co-axially with said drum and radially inwardly of one end thereof when deflated; and means for inflating first the inner bladder and then the outer bladder while the inner bladder remains inflated, whereby an annular edge of said ply which extends axially beyond said one drum end is caused to turn around said core member by sequential inflation of said bladders.

According to a second and alternative aspect of the present invention, there is provided a method of turning up an edge of a cylindrical carcass ply around an annular bead core during the formation of a tyre by means of a double bladder arrangement having differently sized, inflatable bladders one of which is located inside the other; both bladders, the ply, and the bead core being co-axial.

We shall explain in more detail below how practical embodiments of apparatus in accordance with this invention can be constructed for turning up and stitching the edge of a carcass ply around a bead core in the process of the tyre manufacture without causing any wrinkles or substantial air inclusion at the bead portion of the tyre.

In our preferred embodiment, the inlets of both bladders are disposed directly below i.e., radially inwardly of the bead core, and thus when the inner bladder is first inflated, the surface of the inner bladder urges the adjacent wall of the outer bladder to force the carcass ply against the radially inner portion of the bead core, after which the outer bladder is continuously inflated to urge its wall to force the carcass ply against the contiguous portion of the bead core (i.e., its side portion and then around its top portion) thus effecting smooth turning up and stitching of the edge of the carcass ply around the bead core without the risk of air inclusion or formation of wrinkles.

An important feature of the apparatus specifically described below is that, because the inner bladder is disposed inside the outer bladder, when the inner bladder is inflated, the wall of the inner bladder presses towards the radially inner portion of the bead core through the wall of the outer bladder, such that the wall of the outer bladder applies pressure across the confronting surfaces of the carcass ply and the radially inner portion of the bead core throughout the turning up operation, with the result that the initial contacting or pressure acting point between the wall of the outer bladder and the carcass ply (and thus the bead core) is continuously shifted along the outer periphery of the bead core from its radially inner portion along its side and around its top portion. This sequential but continuous pressure of the wall of the outer bladder against the bead core prevents the formation of wrinkles and inclusion of air at the bead portion thus formed.

The invention is hereinafter more specifically described by way of example only with reference to the accompanying drawings, in which:—

Fig. 1 is a side view with portions broken away of one embodiment of a tyre building machine incorporating apparatus for turning up an edge of a carcass ply around a coaxial annular bead core member in accordance with the present invention;

Fig. 2 is a sectional view of part of the apparatus of Figure 1, showing the bladders prior to inflation;

Fig. 3 is a partial sectional view of the apparatus of Fig. 2 in which the inner bladder is in the course of inflation; and

Fig. 4 is a partial sectional view of the apparatus shown in Figs. 2 and 3, showing the inner and outer bladders in the fully inflated condition.

As will be clear from Fig. 1, in the illustrated embodiment a drum shaft 10 has one end rotatably supported in a first stand 11 and is adapted to be rotated by means of a drive motor (not shown) mounted in the stand 11. Fixedly mounted on the other

end 10a of the drum shaft 10 is a tyre building drum 12 capable of radial contraction and expansion of the diameter of its outer surface. The drum shaft 10 is mounted in the first stand in a cantilever fashion and adapted to be rotated together with the tyre building drum 12.

Opposite and spaced from the first stand 11 is a second stand 13, in which there is mounted a first cylinder 14 which receives therein a piston rod 15 slidable in a horizontal direction. The piston rod 15 is coaxial with the drum shaft 10 and has a cylindrical inner casing 16 bolted thereto through its tip portion 15a. The inner surface 16a of the first inner casing 16 is designed to engage outer periphery 10b of the drum shaft 10, as shown in Fig. 1. When the piston rod 15 is moved or retracted leftwardly, the first inner casing 16 will be moved leftwardly, thus being detached from the drum shaft 10.

Fixedly mounted on the outer periphery 16b of the first inner casing 16 is a mounting body 17, the construction of which will be described in detail hereinafter with reference to another mounting body 18 located to the right of body 17 in Fig. 1.

A first outer casing 19 is slidably mounted coaxially on the piston rod 15. One end of a piston rod 20 is affixed to the lower portion of the first outer casing 19, while the other end of the piston rod 20 is slidably mounted in a second cylinder 21 mounted in the lower portion of the stand 13 below the first cylinder 14, as shown. The upper side portion of the first outer casing 19 has an opening, through which piping 22 is led for connection to the mounting body 17 fixed to the first inner casing 16 and to the bladders hereinafter described.

It should be noted that the first outer casing 19 is separately mounted from both piping 22 and the first inner casing 16, thus allowing axial movement relative thereto.

Accordingly, when the second cylinder 21 is actuated, the piston rod 20 and the first outer casing 19 will be axially moved together. On the other hand, when the first cylinder 14 is actuated, the piston rod 15, the first inner casing 16 and piping 22 will be moved axially together.

The relation between the tyre building drum 12, a second outer casing 23 and a second inner casing 24 will now be described.

The second outer casing 23 has a surface 23a matching with the peripheral surface 10b of the drum shaft 10 and is slidable on the peripheral surface 10b of the drum shaft. The second outer casing 23 is cylindrical and is integrally formed with a bead setter 25 on the end 23b thereof having a

somewhat J-shaped cross-section.

The inner side of the bead setter 25 is formed with a curved surface 25a.

The bead setter 25, as shown in Fig. 2, has a flange portion 25b at its radially inner portion, as shown, adapted to mount a bead locating ring 26. A bead core 27 is mounted on the bead locating ring 26 for a turning up operation to commence.

The second inner casing 24 is formed with an inner surface 24a adapted to be slidably mounted on the peripheral surface 10b of the drum shaft 10. A mounting body 18 is fixedly mounted on the outer peripheral surface of the second inner casing 24. An opening 24c is provided in a flange portion 24b of casing 24. The end of piping 28 is in registration with the opening 24c. The piping 28 extends from the opening 24c through an opening 23c in a flange portion of the second outer casing 23 and then into the first stand 11. One end of a piston rod 29 is affixed to the flange portion 24b of the second inner casing 24 while the other end is received in a third cylinder 30 located in the first stand 11. When actuated, the piston rod 29 extends through an opening (not shown) in the second outer casing.

Thus, when the third cylinder 30 is actuated, the piston rod 29, the second inner casing 24 and piping 28 will be axially moved together.

In contrast thereto, the second outer casing 23 is connected via a piston rod 31 to a fourth cylinder 32 located in the first stand 11 and is adapted to be axially moved together with the bead setter 25 when the fourth cylinder 32 is actuated.

The mechanism provided on the first inner casing 16 is identical to that on the second inner casing 24 in a symmetrical fashion, and thus the description will be provided only with reference to the second inner casing 24.

Turning now to Fig. 2, a first ring 33, a second ring 34, a third ring 35, a fourth ring 36 and a fifth ring 37 are located in the order shown, the rings 33, 34, 35 and 36 being secured to the fifth ring 37 which is integral in the mounting body 18 by means of a bolt 38 and a nut 39. Alternatively, these rings 33 to 37 may be directly attached to the second inner casing 24 without using the mounting body 18.

A main bladder 40 has one edge 40a which is rigidly held between the first ring 33 and the second ring 34, and its other edge 40b rigidly held between the fourth ring 36 and the fifth ring 37. The edges 40a and 40b should preferably be formed with enlarged or flange portions as shown, thus accommodating positive, airtight engagement.

Located within the main bladder 40 on

the left side in the drawing in its deflated condition is a subsidiary or inner bladder 41. The subsidiary bladder is thus shown located in Fig. 2 within that portion of the outer bladder which most extends toward the remote end of the drum 12. One edge 41a of the inner bladders rigidly interposed between the second and the third rings 34, 35 and the other edge 41b thereof is interposed between the third ring 35 and the fourth ring 36 in the same manner. Preferably, the edges 41a and 41b are also formed with enlarged or flange portions, thus ensuring positive, airtight engagement. We have found that if the thickness  $t_1$  of the second ring 34 is smaller than the thickness  $t_2$  of the fourth ring 36, the turning up operation is improved.

For best results, both the main bladder 40 and the subsidiary bladder 41 may be made from a sheet in which non-extensive cords of nylon, for example, are embedded radially in a nonpermeable rubber layer. The ratio, in size, of the main bladder 40 to the subsidiary bladder 41 should preferably be approximately 3:1 in terms of the axial width of the collapsed bladder as shown in Fig. 2.

A through-hole or inlet 36a is provided in the fourth ring 36 for the purpose of admitting pressurized fluid. The inlet is adapted to allow communication of the inner space (x) of the main bladder 40 with a main pipe 42 coupled to the lower end of the inlet 36a.

Likewise, a through-hole 35a is provided in the third ring 35, allowing communication of the inner space (y) of the subsidiary bladder 41 with the subsidiary pipe 43 coupled to the lower end of the inlet 35a for admitting pressurized fluid.

The main pipe 42 and the subsidiary pipe 43 are in communication with a pressure source (not shown) provided in the first stand 11, the pipes 42 and 43 being channelled through the piping 28. In general, the pressure source delivers compressed air in the range of 0.5 to 1 kg/cm<sup>2</sup> to the main pipe 42 and subsidiary pipe 43.

It should be recognized that the positions of the inlets 35a and 36a are preferably located below the bead core 27 as shown in Fig. 2, i.e., almost exactly radially inwardly of the bead portion.

In operation, a strip of tyre material 44, which eventually forms a carcass ply, is wound around the outer periphery 12a of the tyre building drum 12 in the contracted condition (not shown), while the drum shaft 10 is slowly rotated. The strip 44 is cut when wound to a required thickness and the cut end is bonded to the remainder of the ply. The tyre building drum 12 is then expanded radially to the shape as shown in

Figs. 1 and 2. While maintaining the wound material 44 on the drum 12 in this manner, the outer casing 23 with a bead core mounted thereon will be brought into proximity with the tyre building drum 12, until the bead core 27 is pressed into contact with one edge portion of the carcass ply. The relation of the bead core 27 and the edge portion of the carcass ply is shown in Fig. 2. The outer casing 19 will similarly carry a bead core which is pressed into contact with the other axial edge portion of the carcass ply. Thereafter the operations are similar at the two axial edge portions of the carcass ply.

The outer casing 23 is retracted to its initial position followed by the steady introduction of pressurized fluid into the subsidiary or inner bladder 41. The pressurized fluid causes the inner bladder 41 to become inflated, thus causing the wall of the main or outer bladder 40, which is adjacent to the wall of the inner bladder 41, to urge the one edge portion of the carcass ply radially outwardly against the adjacent radially innermost part of the bead core at its left hand end as seen in Fig. 3, so that the part of the edge portion of the carcass ply closest to the region held between the end 12b of the tyre building drum 12 and the bead core 27, is the first part to be turned. As the inner bladder 41 continues to inflate, the wall of the outer bladder will progressively urge the carcass ply against the entire radially innermost portion of the bead core from left to right as shown. Fig. 3 shows the inner bladder in the course of being inflated.

Subsequently, pressurized fluid is steadily introduced through the main pipe 42 into the outer bladder 40. As the outer bladder 40 is being inflated, the edge portion of the carcass ply is pressed first against the axially outer or side portion of the bead core and then around the radially outermost portion of the bead core, thus completing the ply turning and stitching operation as shown in Fig. 4. In this respect, it should be noted that the contact or pressure acting point of the wall of the outer bladder 40 via the carcass ply against the bead core 27 is continuously shifted along the periphery of the bead core from its radially innermost portion, along its side or axially outer portion, and around its radially outermost portion, thus preventing the risk of including air between the bead core and the edge of the carcass ply or the danger of forming wrinkles at the bead portion.

Pressure applied externally to the outer bladder 40 as represented symbolically by arrows A in Fig. 4, by means of a suitable concave backing means will facilitate turning of the carcass ply around the bead core.

The backing means causes the bladder 40 to adopt the U-shaped cross-section evident in Fig. 4.

As shown in Fig. 1, such backing means is conveniently provided on the bead setter 25 in the form of the previously mentioned curved surface 25a.

Upon completion of the turning operation, the outer casing 23 is retracted to its initial position, with the pressurized fluid in the outer and inner bladders 40 and 41 being withdrawn, whereupon the inner casing 24 is retracted, similar operations taking place at the other axial end of the tyre. The subsequent operations for forming remaining tyre layers including the tread layer are the same as in a conventional method for building a green tyre.

Finally, the tyre building drum 12 is radially contracted, and the green tyre is removed through the gap between the retracted first inner and outer casing 16, 19 and the tyre building drum 12.

It should be noted that the wall of the main bladder 40 is in direct contact with the edge of the carcass ply throughout the turning and stitching operation without discontinuity in operation, thus providing, in our opinion the best possible quality for the bead portion of the tyre, i.e., free of any wrinkle or air inclusion defects of any kind.

#### WHAT WE CLAIM IS:

1. Apparatus for turning up an edge of a cylindrical carcass ply around a coaxial annular bead core member during manufacture of a tyre, the apparatus comprising: a drum for supporting said ply coaxially thereon; means for pressing said core member coaxially against one end of said drum; a multi-bladder arrangement including two inflatable bladders, one of which is located inside the other, the bladders being mounted coaxially with said drum and radially inwardly of one end thereof when deflated; and means for inflating first the inner bladder and then the outer bladder while the inner bladder remains inflated, whereby an annular edge of said ply which extends axially beyond said one drum end is caused to turn around said core member by sequential inflation of said bladders.

2. Apparatus according to Claim 1, wherein the surface area of said inner bladder in its deflated state is substantially smaller than that of said outer bladder in said state and the inner bladder in said state is disposed within that portion of the outer bladder which most extends toward the other end of said drum.

3. Apparatus according to Claim 2, wherein the ratio of the widths in the axial direction of the outer bladder to the inner bladder is approximately three to one when the bladders are collapsed.

4. Apparatus according to any preceding

claim wherein said means for pressing said core member has a curved backing surface formed thereon for shaping the profile of said outer bladder when inflated.

5 5. Apparatus according to Claim 4, wherein said outer bladder when inflated adopts a U-shaped axial section by virtue of said backing means.

10 6. Apparatus according to Claim 1, further comprising means for causing said outer bladder when inflated to adopt a U-shaped axial section such that the edge of said ply is forced around said core member and back towards said drum.

15 7. Apparatus according to any preceding claim wherein each of said bladders has an inner opening defined by a pair of annular, axially spaced, radially inner edges, and further comprising means for sealingly clamping said annular inner edges of said bladders respectively.

20 8. Apparatus according to claim 7, wherein said clamping means includes a plurality of coaxial ring-shaped members, a first one of which is disposed between the two inner edges of said inner bladder, and a second one of which is disposed between adjacent inner edges of said inner and outer bladders on one side of said first ring-shaped member, separate inlet ports communicating with said inflating means being defined respectively through said first and second ring-shaped members.

35 9. Apparatus according to Claim 8, wherein said plurality of ring-shaped members further includes a third ring-shaped member disposed between the adjacent inner edges of said inner and outer bladders on the other side of said first ring-shaped member.

40 10. Apparatus according to Claim 9, wherein said third ring-shaped member is closer to the other end of said drum than said second ring-shaped member, and said second member has an axial thickness substantially greater than that of said third

ring-shaped member.

11. A method of turning up an edge of a cylindrical carcass ply around an annular bead core during the formation of a tyre by means of a double bladder arrangement having differently sized, inflatable bladders one of which is located inside the other; both bladders, the ply and the bead core being co-axial.

12. A method according to Claim 11, wherein pressurized fluid is supplied by separate inlet ports to the bladders for inflating the same.

13. A method according to Claim 11 or 12, wherein the edge of the ply between the bead core and the bladders is forced to turn around the bead core by continuous inflation of first the inner bladder and then the outer bladder.

14. Apparatus for turning up an edge of a cylindrical carcass ply around a co-axial annular bead core member, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

15. Tyre building apparatus incorporating apparatus according to any of Claims 1 to 10 or 14 for turning up an edge of a cylindrical carcass ply around a co-axial annular bead core member.

16. A method of turning up an edge of a cylindrical carcass ply around an annular bead core during the formation of a tyre, the method being substantially as hereinbefore described with reference to the accompanying drawings.

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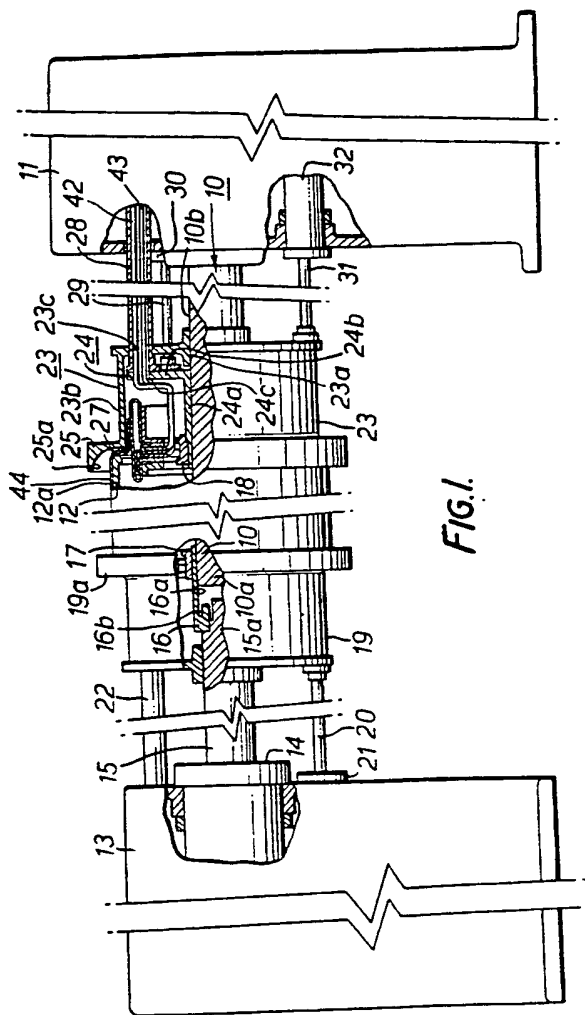
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COMPLETE SPECIFICATION

3 SHEETS

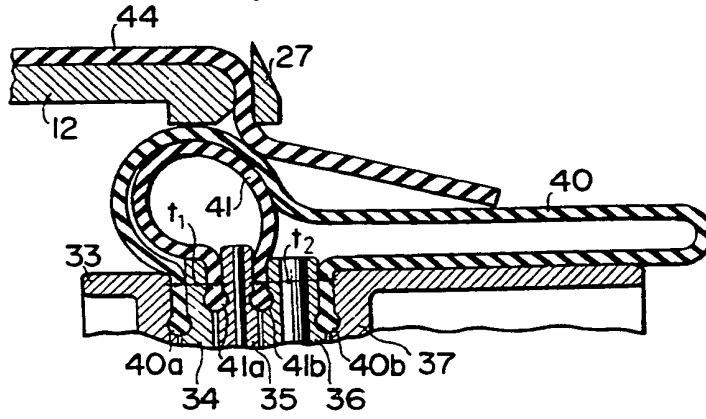
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Sheet 1

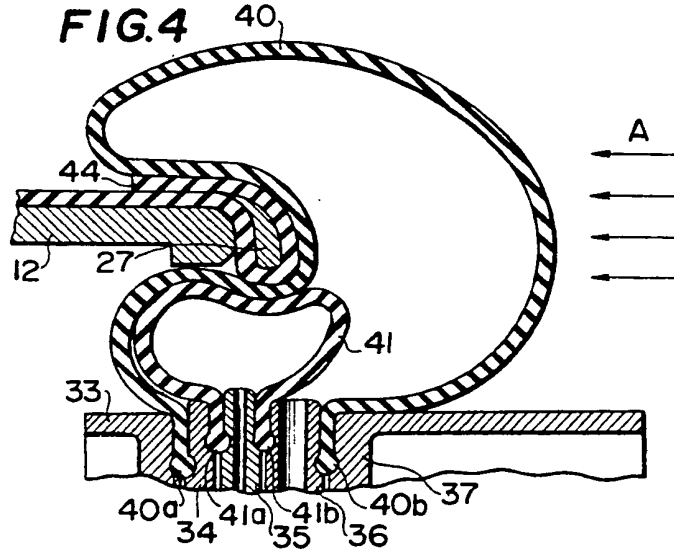


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**FIG. 3**



**FIG.4**



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